



School of Nano Science



IPM Condensed Matter &  
Statistical Physics Group

## Weekly Seminar

# Nonlinear optical devices as interfaces for long distance quantum communications

Invited Speaker:

**Vahid Esfandyarpour**

Department of Applied Physics, Stanford University

### **Abstract:**

Today, the primary methods of communication are based on binary switches using digital logic in classical semiconductor devices. Quantum information processing enables superpositions of the binary states to evolve at the same time which is not possible in classical systems. A quantum computer can solve certain problems exponentially faster than classical computers. Quantum network consists of a number of quantum nodes which interacts with each other over a quantum channel while separated by some distances.

The need for interfaces between quantum nodes and low-loss channels in long-distance quantum communication networks motivates the development of quantum frequency conversion (QFC) processes, in which a qubit's carrier frequency is translated while its quantum state is maintained. This requires efficient and low-noise conversion of single photons. The use of periodically poled lithium niobate waveguides has enabled conversion efficiencies exceeding 99.99%. Therefore, reducing the generation rate of noise photons due to spontaneous scattering processes is important for these parametric single-photon conversion processes.

In this talk, I will discuss the influence of propagation loss on the optimal waveguide design, to reduce the required pump power for complete conversion of the input photons, resulting in a proportional reduction in the noise photons. I will also present a novel cascaded device for two-stage downconversion of single-photon-level signals at 650 nm to the low-loss telecom band with low excess noise and low required pump power as a quantum interface between matter qubit-based nodes and low-loss photonic channels for long-distance quantum communication networks.

Wednesday, 26<sup>th</sup> of Aban (1395) (November 16<sup>th</sup>, 2016), 14:00-15:00

Farmaniyeh seminar room